



Lawrence Berkeley National Laboratory

Solutions For the Developing World

Efficient Cookstoves for Darfur, Ethiopia



Billions of people around the world cook their meals on rudimentary stoves fueled by burning wood or other biomass, resulting in smoke and carbon emissions that both damage human health and pollute the environment. For women living in refugee camps in Darfur, the problem is compounded

because they often walk miles to gather firewood, exposing them to violence.

To address these issues, Berkeley Lab scientist Ashok Gadgil designed the Berkeley-Darfur stove, which uses up to three times less wood than the traditional three-stone stoves and prevents up to two tons of carbon dioxide emissions annually. The Darfur Stoves Project was established to produce and distribute the stoves and has support from the Blum Center for Developing Economies and the Sustainable Products and Solutions Program. In a partnership with Oxfam America and the Sustainable Action Group, a Sudanese charity, thousands of the stoves are being assembled and distributed in Darfur.



Separately, Gadgil and his group are working with World Vision to adapt the stove for use in Ethiopia, which has experienced severe deforestation. About 80 percent of the population still uses traditional three-stone fires to prepare meals; and the average household uses 11 kg of wood-equivalent per day, or 4 metric tons annually. The scientists are working not only to create a more efficient stove specific for use in Ethiopia, but to finance the project by selling carbon credits on the world carbon market.

Learn more at: www.darfurstoves.org

Arsenic-free Water for Bangladesh

Some 70 million Bangladeshis are drinking arsenic-contaminated well water, causing one in five deaths in that country, according to a recent study in *The Lancet*. Although the World Health Organization's recommended maximum limit for arsenic in drinking water is 10 ppb, the arsenic levels in Bangladesh, in some cases, exceed 1,000 ppb. Several technologies have attempted to address this devastating problem, but nearly every one has failed in implementation.



Scientists at Berkeley Lab, in collaboration with UC Berkeley, have developed two low-cost, sustainable solutions to the problem accompanied by an innovative business model that is informed by culturally relevant data, lessons from failed technologies and implementations, and public-health success stories from other parts of South Asia. ARUBA (arsenic removal using

bottom ash) and ECAR (electrochemical arsenic remediation) provide cost-effective water remediation in small facilities designed to supply drinking water for about 500 to 1,000 people. Berkeley Lab researchers estimate the cost of just the technical arsenic remediation of 10 liters of water per day (needed per person) to be about \$1 annually using the ECAR method and between \$7 and \$15 annually using the ARUBA method. (ECAR needs a small amount of electricity, while ARUBA does not.)

Learn more at: arsenic.lbl.gov

UV Waterworks: Clean Water to Save Lives



In 1992-1993, a mutant strain of cholera (the “Bengal Cholera”) hit India, Bangladesh and several other countries, killing thousands of people. The standard vaccine was ineffective

and most of the populace of India could not afford to boil their drinking water to protect themselves. Ashok Gadgil, a Berkeley Lab scientist, spurred to action by the tragedy, developed an affordable, effective and low-maintenance water disinfection system employing ultraviolet (UV) light. Cleaning water at four gallons/minute for pennies a gallon, UVWaterworks has been licensed by WaterHealth International and installed in more than 10 countries around the world; by early 2010 these systems were bringing clean water to over 2 million people. Water-borne diseases, such as dysentery, are the largest environmental cause of child and infant mortality in the developing world, killing about 2 million children annually.

Learn more at: eande.lbl.gov/iep/archive/uv

Using Synthetic Biology to Create a Low-cost Malaria Drug

Malaria has become increasingly resistant to first-line drug therapies, but combination drugs containing artemisinin derivatives show nearly 100 percent effectiveness against the malaria parasite. Yet, at a price of approximately \$2.20 per adult course, these drugs are still beyond the reach of the world's poorest people. Using the tools of synthetic biology,



Berkeley Lab scientist Jay Keasling created a microbial precursor to artemisinin by adding new genes and engineering a new metabolic pathway in *Escherichia coli* bacteria.

According to the World Health Organization, each year nearly 500 million people living in the tropics and subtropics become infected with malaria, suffering burning fever and severe pain. Nearly three million—mostly children—die. With a grant from the Bill and Melinda Gates Foundation, the Artemisinin Project was established as a partnership of the Institute for OneWorld Health, Amyris Biotechnologies, Sanofi-Aventis, and the University of California, Berkeley to make life-saving artemisinin combination therapies more accessible to people in the developing world.

Learn more at: www.oneworldhealth.org/malaria

Lighting the Developing World

Thomas Edison's seemingly forward-looking statement that “we will make electricity so cheap that only the rich will burn



candles” was true enough for the industrialized world, but it did not anticipate the plight of 1.6 billion people—more than the world's population in Edison's time—who 100 years later still have no access to electricity. The Lumina Project began by identifying and quantifying the much-overlooked specter of fuel-based lighting in the developing world. Researchers found that those at the bottom of the economic pyramid spend \$38 billion each year on inefficient, ineffective, and polluting light from kerosene and other fuels. They then identified the potential of compact, rugged, and affordable light-emitting diode (“LED”) systems to displace these fuels, while providing radically improved energy services. As NGOs and private companies engage in bringing solutions to the market, the Lumina Project, with support from the Blum Center for Developing Economies, evolves with them and continues to help accelerate technology innovation and the development of markets.

Learn more at: light.lbl.gov